(12) UK Patent Application (19) GB (11) 2 193 624 (13) A

(43) Application published 17 Feb 1988

(21) Application No 8619667

(22) Date of filing 13 Aug 1986

(51) INT CL⁴
A23L 3/18

(52) Domestic classification (Edition J):
A2D 24 2A 2C1 2C3 2C8 2E2 PK PR X2
U1S 1081 1274 A2D

(56) Documents cited
GB A 2176688 US 3934042 US 3578463
GB A 1143272

(58) Field of search
A2D
Selected US specifications from IPC sub-class A23L

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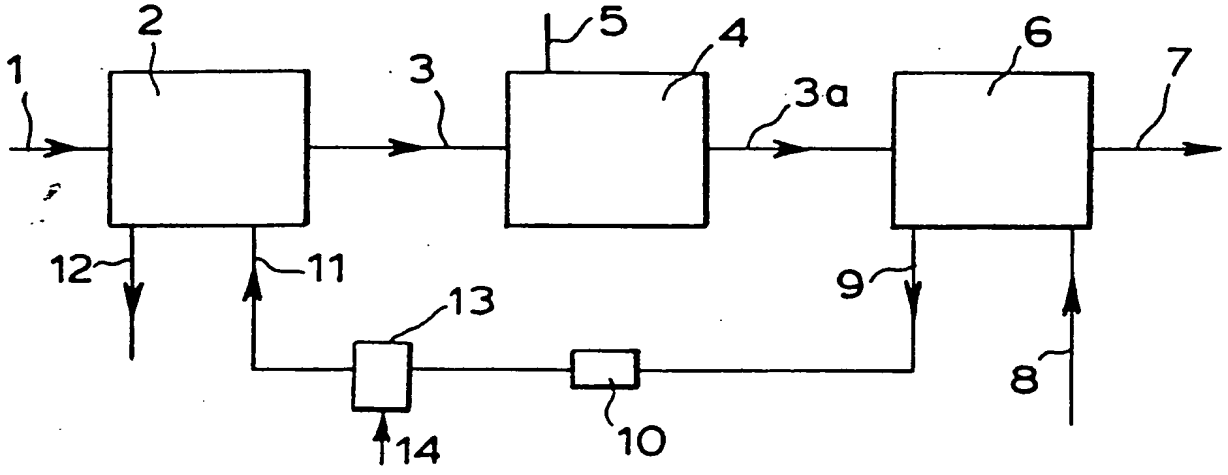
(54) Heat treatment of slurries

(57) Sterilization or other heat treatment of particulate slurries with a holding time at high temperature of the order of a few seconds, involves feeding the slurry continuously through a pre-heating scraped surface heat exchanger 2 to transfer a substantial proportion of the required sensible heat into the slurry, and subsequently feeding it continuously through a radiation field. The radiation field in the apparatus of Fig. 1 is of micro-waves fed into an enclosure 4, whereby the particles are subject to heating from the interior. The slurry may be passed over static mixing devices in its passage through the enclosure 4. Alternatively, use may be made of an electron beam, or X-rays or gamma rays. After a short holding time for sterilization, the slurry is cooled in a further scraped surface heat exchanger 6.



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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

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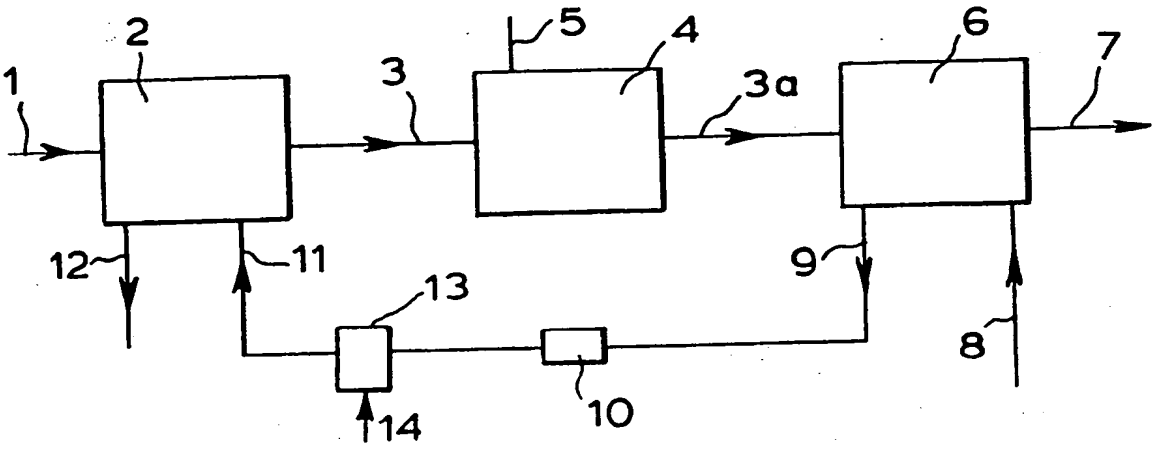

SPECIFICATION

Heat treatment of slurries

This invention relates to the heat treatment, such as sterilization, of slurries, and in particular to the continuous treatment of slurries having solids contents of substantial particle size.

The invention is of particular application in the food industry for the cooking and sterilization of slurries, consisting of particulates in a carrier liquid, such as meat products in sauces or fruit or vegetables in a syrup or cream. In such slurries, the particles of solid product may well have a thickness dimension of up to 3/4 inch (say 2 cm), and, in particular, the product may be in generally cubic form. Even with cubes of inch (say 0.6 cm) side, there is a well-known problem of obtaining adequate thermal treatment at the centre of the particles, without overheating or overcooking of the surface layers, and ensuring quasi-homogeneity of the slurry during treatment.

The continuous heat treatment of such particulate slurries is normally carried out in scraped surface heat exchangers. In order to achieve an adequate time at the high temperature to ensure thorough treatment, resort is normally had to holding the slurry at an elevated temperature or to recycling or multiple passage through the heat exchanger. The required heating time is determined by the thermal diffusivity of the solid material, and it is normal to employ a scraped surface heat exchanger of which the residence time for the flowing material is considerably less than the total heating time required to acheive cooking or sterilization. Consequently, a holding period is required in a through-flow vessel or pipe before the product enters a cooling device.

If the required holding period is of the order of a few seconds only, then it can be achieved without undue difficulty, since the short pipe length required will not give rise to stratification or product settling. However, for all but very small particles several minutes holding are required. This gives rise to stratification, which causes unequal residence times, and/or to product damage.

When meat cubes of 1/4 inch (0.6 cm) side are involved, the holding time at sterilizing temperature needs to be in the region of one to two minutes for adequate treatment at the centres of the cubes. With larger cubes, e.g. 3/4 inch (2 cm) side, the holding time required is normally between 2-1/2 and 6 minutes. Such long periods at the temperature range of 100-150°C cannot be accommodated without product damage and/or stratification.

It is an object of the invention to provide a method in which sterilization or other adequate heat treatment may be achieved with a holding time at high temperature of the order of a few seconds.

If treatment is carried out in batches, then the product has to be held stationary, and the solid content may settle, thus destroying the quasi-homogeneity which is important in maintaining proper control of the process.

A full thermal treatment in a micro-wave field necessitates expensive equipment, and a high energy cost compared with a steam or hot water heated scraped surface heat exchanger.

It has been found that advantages accure from combining the indirectly heated process with a micro-wave or other radiation system.

In accordance with a first aspect of the invention, there is provided a method for the continuous heat treatment, and particularly sterilization, of a particulate slurry, in which the slurry is fed continuously through a preheating heat exchanger to transfer a substantial proportion of the required sensible heat into the slurry, and is subsequently fed continuously through a radiation field for a short period prior to cooling.

In accordance with a second aspect of the invention, there is provided apparatus for the continuous heat treatment, especially sterilization, of a particulate slurry, comprising a preheating heat exchanger to transfer a substantial proportion of the required sensible heat into the slurry fed continuously therethrough, means for generating a radiation field, means for feeding the slurry continuously through the radiation field, and means for subsequently cooling the slurry.

The radiation field may be of micro-waves for in-line sterilizing, whereby the particles are subject to heating from the interior. As an example, some two thirds of the required heat could be transferred into the slurry by a scraped surface heat exchanger, and the remainder applied in the micro-wave treatment. After the micro-wave treatment, the slurry is normally cooled in a conventional manner, preferably in a further scraped surface heat exchanger.

In view of the internal heating arising from the micro-wave treatment, a full heat treatment to sterilization is possible with only a short residence time at high temperature, and thus without detriment to the appearance or flavour of the product. A holding period in the region of 2 to 10 seconds is appropriate for the sort of slurries concerned to obtain thorough sterilization, and this short holding period limits the stratification and damage to the product.

This combination of pre-heating by scraped surface heat exchanger and final heating by micro-wave radiation limits the size and cost of the equipment for the radiation field, and thereby solves the problem of heating and holding a particulate slurry in an economical manner. The cooling is by conventional equipment.

The invention is also applicable in connection with the preparation and packaging of

partially cooked or thermally sensitive products. The partial cooking or pre-heating takes place in a scraped surface or other conventional heat exchanger, but instead of micro-waves, it is preferred to use an electron beam, or X-rays or gamma rays, for the sterilization immediately prior aseptic packaging.

In the case of cooked products, this achieves cooking without adverse organoleptic effects and renders the product sterile.

The slurry may be advantageously passed over static mixing devices in its passage through a holding device, for example a tube, in the radiation field so as to make most effective the treatment by radiation of all the particles in transit.

In accordance with a third aspect of the invention, there is provided a slurry when heat treated, particularly sterilized, by a method or in an apparatus in accordance with the invention as set forth above.

The invention will be further described with reference to the accompanying diagrammatic drawing, of which the sole figure is a flow diagram showing one form of apparatus in accordance with the invention for carrying out the process of the invention.

Turning first to figure 1, a prepared slurry enters by a line 1 into a scraped surface heat exchanger 2 for preheating by the addition of some two thirds of the total sensible heat required.

In the case of non-acid foods, the temperature of the liquid phase will normally reach between 125°C and 150°C. For acid foods, the temperature range will normally be lower, e.g. in the range 85°C to 125°C.

From the heat exchanger 2, the preheated slurry flows via a line 3 into and through an irradiation chamber 4 wherein it is subjected to intensive heating by micro-wave energy fed in along a wave guide 5.

In order to prevent leakage of micro-wave energy from the enclosure 4, it must be electrically isolated from the upstream and downstream equipment, which will normally be constructed from stainless steel. This isolation must occur in the feed line and the exit line 3a. The sterilized slurry passes along the exit line 3a and into a second, cooling scraped surface heat exchanger 6, and from thence it passes via a line 7 to an aseptic packaging plant.

The preheating scraped surface heat exchanger 2 is shown as being regenerative in form, in that a cooling medium for the heat exchanger 6 is fed in along a line 8 and the heated medium out along a line 9 which also serves as an inlet line to a pump 10 supplying the heated liquid along an inlet line for the heating medium to the scraped surface heat exchanger 2. Addtional heat input is provided via a steam injector or indirect heater 13, shown as having an input 14. The cooled medium is then discharged via a line 12, and is preferably recirculated to the cooling heat exchanger 6 via the line 8.

In an alternative procedure, use may be made of an irradiation enclosure where the slurry is irradiated for sterilizing the product by means of an electron beam, X-rays or gamma rays.

Various other modifications may be made within the scope of the invention.

CLAIMS

1. A method for the continuous heat treatment of a particulate slurry, in which the slurry is fed continuously through a pre-heating heat exchanger to transfer a substantial proportion of the required sensible heat into the slurry, and is then fed continuously through a radiation field for a short period prior to cooling.

2. A method as claimed in claim 1, in which the radiation field is of micro-waves, whereby the particles are subject to heating from the interior.

3. A method as claimed in claim 1, in which the radiation field uses an electron beam, or X-rays or gamma rays.

4. A method as claimed in any of the preceding claims, in which the slurry is passed over static mixing devices in its passage through the radiation field.

5. A method as claimed in any of the preceding claims, in which the slurry is sterilized in its passage through the radiation field.

6. A method for the continuous heat treatment of a particulate slurry substantially as hereinbefore described with reference to the accompanying drawings.

7. Apparatus for the continuous heat treatment of a particulate slurry, comprising a preheating heat exchanger to transfer a substantial proportion of the required sensible heat into the slurry fed continuously therethrough , means for generating a radiation field, means for feeding the slurry continuously through the radiation field, and means for subsequently cooling the slurry.

8. Apparatus as claimed in claim 7, in which the radiation field is of micro-waves.

9. Apparatus as claimed in claim 7, in which the radiation field uses an electron beam, or X-rays or gamma rays.

10. Apparatus as claimed in any of claims 7 to 9, comprising static mixing devices over which the slurry is passed in its passage through the radiation field.

11. Apparatus as claimed in any of claims 7 to 10, in which the pre-heating heat exchanger is a scraped surface heat exchanger.

12. Apparatus as claimed in any of claims 7 to 11, in which the cooling means is a scraped surface heat exchanger.

13. Apparatus for the continuous heat treatment of a particulate slurry substantially as hereinbefore described with reference to the accompanying drawings.

14. A slurry when heat treated by a method

as claimed in any of claims 1 to 6 or in an apparatus as claimed in any of claims 7 to 13.

Published 1988 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office, Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Burgess & Son (Abingdon) Ltd. Con. 1/87.